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Spatial distribution of fifty ornamental fish species on coral reefs in the Red Sea and Gulf of Aden

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Abstract

The spatial distribution of 50 ornamental fish species from shallow water habitats on coral reefs were investigated using visual census techniques, between latitudes 11–29°N in the Red Sea, in Jordan, Egypt, Saudi Arabia, and Yemen, and in the adjacent Gulf of Aden in Djibouti. One hundred eighteen transects (each 100×5 m) were examined in 29 sites (3–8 sites per country). A total of 522,523 fish individuals were counted during this survey, with mean abundance of 4428.2 ± 87.26 individual per 500 m^2 transect. In terms of relative abundance (RA), the most abundant species were Blue green damselfish, *Chromis viridis* (RA=54.4%), followed by Sea goldie, *Pseudanthias squamipinnis* (RA= 34.7), Whitetail dascyllus, *Dascyllus aruanus* (RA= 2.6%), Marginate dascyllus, *Dascyllus marginatus* (RA= 2.0), Red Sea eightline flasher *Paracheilinus octotaenia* (RA=1.0), and Klunzinger's wrasse, *Thalassoma rueppellii* (0.7%). The highest number of species (S) per 500 m^2 transect was found on reefs at the latitude 20° in Saudi Arabia (S=21.8), and the lowest number of species was found at the latitude 15° in Djibouti (S=11.11). The highest mean abundance (8565.8) was found on reefs at latitude 20° in Saudi Arabia and the lowest mean abundance (230) was found on reefs at latitude 22°, also in Saudi Arabia. Whereas, the highest Shannon-Wiener Diversity Index was found in reefs at the latitude 22° (H`=2.4) and the lowest was found in reefs at the latitude 20° (H`=0.6). This study revealed marked differences in the structure of ornamental fish assemblages with latitudinal distribution. The data support the presence of two major biogeographic groups of fishes in the Red Sea and Gulf of Aden: the southern Red Sea and Gulf of Aden group and the group in the northern and central Red Sea. Strong correlations were found between live coral cover and the number of fish species, abundance and Shannon-Wiener Diversity indices, and the strength of these correlations varied among the reefs. A conclusion was done that environmental differences among the reefs and the habitats investigated were important components of abundance variations and species diversity of ornamental fish along latitudinal gradients in the Red Sea and the Gulf of Aden.

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Keywords
Fish community structure, coral reef fishes, Aquarium fishes, Biogeographical affinities, Red Sea and Gulf of Aden

Introduction

Coral reefs are valuable and important ecosystems. They are among the most productive and diverse of all-natural ecosystems, and they are often called «the tropical rain forests of the sea» (Bourilere and Harmelin 1989). Coral reefs have many functions, amongst which is the provision of a variety of habitats for a wealth of organisms. Fishes are a dominant group of coral reef fauna, in terms of both their biomass and diversity. They are the most visible and important mobile component in the coral reefs (Letourneur et al. 1999). Reef ecosystems provide fishes with shelter, feeding, spawning and nursery grounds. Pollution, destructive fishing, over-fishing, coral bleaching, tourism development and other stresses and activities threaten these valuable ecosystems.

While the Red Sea fish fauna is taxonomically quite well known (Randall 1992, Goren and Dor 1994, Khalaf 2004) compared with other parts of the tropical Indo-Pacific Ocean, the community structure of shore fishes has been less well investigated (Khalaf and Kochzius 2002). Despite a long tradition of taxonomical work (e.g. Forsskal 1775, Klunzinger 1884), few studies have been published on the general community structure of the Red Sea shore fishes (Bouchon-Navaro 1980, Ben-Tuvia et al. 1983, Rilov and Benayahu 2000, Khalaf and Kochzius 2002, Alwany and Stachowitsch 2007) and these studies cover a small range of spatial distribution. Most species of near-shore fishes in the Red Sea associate with coral reefs, although some occur in sea grasses, sandy areas, and other near-shore habitats (UNEP 1997). The present study was carried out through the Sustainable Use and Management of Living Marine Resources component of the Strategic Action Programme for the Red Sea and Gulf of Aden (SAP) executed by The Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden (PERSGA) between 1999 and 2003. The study was conducted at coral reef sites to assemble comparative regional data on the distribution of fifty ornamental fish species at latitudinal (11–29°N) spatial scales. The main objectives of the study were to assess the community structure, and biogeographic affinities of Red Sea coral reef fishes that are collected for the aquarium trade.

Material and methods

Study area

The study was conducted at coral reef sites at latitudes between 11–29°N along the coasts of Jordan, Egypt, Saudi Arabia, Yemen in the Red Sea and just outside the Red Sea in the Gulf of Aden, for Djibouti (Fig. 1).

Figure 1. Map of the Red Sea and Gulf of Aden. Squares indicate the coral reef sites examined in the present study.

Visual census

We selected 50 ornamental reef fish species that occur in shallow water habitats on coral reefs only. Based on the information collected from fishermen and Government authorities in member countries of (PERSGA), most of the sites and depths in Egypt, Saudi Arabia and Yemen were selected in sites used by collectors of the ornamental fishes. Whereas, the sites in Jordan and Djibouti were collection of ornamental fishes did not take place was carried out in coral reef sites. The abundance of each species was surveyed along the coasts of Jordan, Egypt, Saudi Arabia, Yemen and Djibouti using a visual census technique by SCUBA divers, as described in English et al. (1994). The visual census technique is a widely used method for ecological studies of fishes on coral reefs. However, differences in skill levels and techniques of observers can be a source of imprecision and/or bias (Thompson and Mapstone 1997). Therefore, only underwater fish counting performed by the first author was used to avoid this type of bias in the present study. A total of 118 transects, each 100m length × 5m width (500m^2) were performed at 29 sites (3–6 transects per site except at Ras Mohamed two transects instead of three at 2–4 m depth were surveyed due to the strong

Table 1. Information on 29 sampling sites along the Jordanian, Egyptian, Saudi Arabian, Yemeni and Djibouti coasts, Red Sea and Gulf of Aden; n=number of transects examined; date of fish counts given for each sampling depth, and position of each site in latitude N and longitude E shown. NR=not recorded. Note: in Yemen, Djibouti, and at some sites in Saudi Arabia, only transects at 2–4m depth were examined.

Country	Latitude	Site	n	2–4m	n	5 m depth	n	10 m depth	N	E	Total No. of transects
Jordan	JO 29°	Marine Science Station			3	26/7/2002	3	26/7/2002	29°26.276, 34°58.275		
		Visiting Center			3	25/7/2002	3	25/7/2002	NR	NR	18
		Tourist Camp			3	24/7/2002	3	24/7/2002	29°26.276, 34°58.275		
Egypt	EG 27°	Noksh			3	11/7/2002	3	11/7/2002	27°46.723, 34°02.915		
		Mahmoudat			3	12/7/2002		12/7/2002	27°44.460, 34°08.881		
		Manar Dolphin			3	13/7/2002	3	13/7/2002	27°42.303, 34°07.133		31
		Elli			3	14/7/2002	3	14/7/2002	27°47.334, 33°53.227		
		Zorab			5	16/7/2002		16/7/2002	27°50.146, 34°00.230		
		Ras Mohamad			2	15/7/2002	3	15/7/2002	27°43.886, 34°15.663		
Saudi Arabia	SA 22°	Bostek/Thoal					3	2/11/2002	22°19.647, 39°02.350		6
		Thoal- Awjam			3	2/11/02			22°19.648, 39°02.351		
	SA 21°	Alkabeera			3	30/10/2002	3	27/10/2002	21°41.581, 39°00.741		21
		Bayada			3	28/10/2002			NR	NR	
		South Batch Bayada			3	30/10/2002	3	29/10/2002	21°44.602, 38°57.798		
		Al-Sagheera			3	31/10/2002			21°39.721, 38°58.850		
		Al-Kherq			3	31/10/2002			21°43.039, 38°59.253		
	SA 20°	Alleeth			3	3/11/2002	3	3/11/2002	20°06.326, 40°13.030		6
Yemen	YE 15°	Kadaman	3	8/10/2002					15°33.949, 42°13.585		18
		Kamaran	3	5/10/2002					15°16.593, 42°36.192		
		Tekfash	3	7/10/2002					15°41.979, 42°23.654		
		Quish	3	7/10/2002					15°41.084, 42°28.110		
		Al-murk	3	8/10/2002					NR	NR	
		Al-Badi	3	9/10/2002					NR	NR	
Djibouti	DJ 12°	Gehere	3	17/10/2002					12°16.662, 43°22.926		3
	DJ 11°	Khor Ambado	3	13/10/2002					11°35.780, 43°01.985		15
		Maskali	3	14/10/2002					11°42.937, 43°09.246		
		Musha	3	14/10/2002					11°44.669, 43°12.440		
		Tajoura	3	15/10/2002					11°46.245, 42°56.860		
		Arta Plaga	3	16/10/2002					11°35.394, 42°49.981		
		Total n	36		49		33				118

water currents occurred during the period of study, Table 1). At each site, a visual census was conducted along three transects, in most cases on the shallow reef slope (4–5 m) and also three transects on the deep reef slope (8–10m). Divers then swam along the transects and recorded individuals of the 50 selected fish species within 2.5 m either side, and 3 m above the transect line for a duration of 25–30 minutes. Fish identification in the field was checked using published guides (Myers 1991, Randall 1992, Smith and Heemstra 1986, Khalaf and Disi 1997). The common name of fishes indicated in this study were after Froese and Pauly 2000 (FishBase 2013). All latitude numbers are for north latitudes.

Surveys of the benthic habitat were carried out by assistants from Saudi Arabia and Yemen. The line-point intercept method was used with the tape stretched taut 200 points recorded per 100-m transect. From this point-intercept data, the percentage cover was calculated of live hard coral, live soft coral, dead coral, coral rock, sand, rubble, macro algae, algal turf, sponge, and others as described by Edwards (2002).

Statistical analysis

Abundance of fishes was described by relative abundance (RA) and frequency of appearance (FA) following Khalaf et al. (2006). RA was calculated as: (pooled average abundance of species *i* at each depth and site / pooled average abundance of all species at each depth and site) × 100. FA was determined as: (number of transects in which species *i* was present / total number of transects) X 100. Species richness (number of species), and Shannon-Weiner species diversity were calculated using PRIMER-E (Polymouth Marine Laboratory, UK, 2000). Multivariate analysis of the data such as cluster analysis was performed using the same software. Analysis of a linear regression test used to examine the relationship between hard coral (HC) and soft coral (SC) vs. species richness (S), fish abundance (N), Shannon-Weiner Diversity Index (H′) as described by Sokal and Rohlf (1981) and implemented using STAT VEIW computer software.

Results

Benthic habitat

Fig. 2 shows the percentage cover of substrate types for various latitudes along the Red Sea and Gulf of Aden.

Jordan

Latitude 29°

Along the Jordanian Gulf of Aqaba coast, the highest hard live coral cover was 47%, occurring at the Visitor Center at 10 m depth. The average live hard coral cover across all sites in Jordan was 27%. The highest soft coral cover was at the Visitor Center at 5 m depth, and the average among all Jordanian sites was 6%.

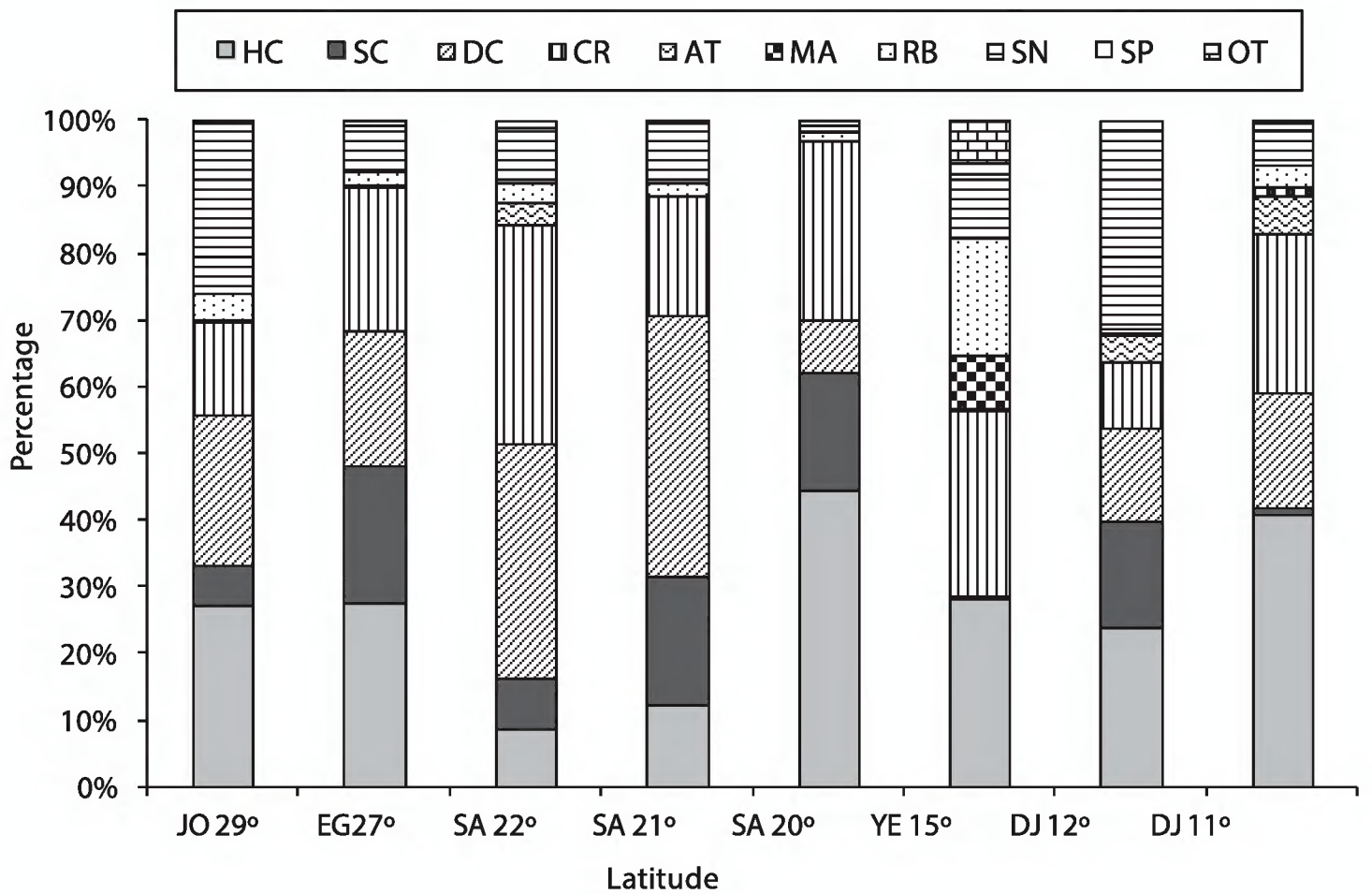

Figure 2. Percent cover (%) for substrate types at all latitudes [(JO=Jordan, EG=Egypt, SA= Saudi Arabia, YE=Yemen, DJ=Djibouti), where (HC=Hard coral, SC=Soft coral, DC=Dead coral, CR=Coral rock, AT=Algal turf, MA=Macroalgae, RB=Rubble, SN=Sand, SP=Sponge, OT=Others)].

Egypt

Latitude 27°

Along the Egyptian coast, the highest hard coral cover was 41.2%, found at both Noksh (5 m depth) and at Mahmoudat (5 m depth). The average of hard coral cover at all Egyptian sites was 27.6%. The highest soft coral cover was 47.8% at Fanar Dolphin and Ras Mohammed respectively, both at 10 m depth. The average soft coral cover at all sites in Egypt was 20.6%.

Saudi Arabia

Latitude 22°

At latitude 22°, the highest hard coral cover was 14%, occurring at Thowal-Awjam at 4 m depth. The average hard live coral at all sites at this latitude was 8.8%. The highest soft coral cover was 5.5% in Thoal-Bostek, at 10 m deep, and the average soft coral cover at all sites at this latitude was 7.7%.

Latitude 21°

The highest hard live coral cover was 35.5% at Bayada, in the deep transect. The average hard live coral cover at all sites was 12.4%. The highest soft coral cover was 81.5% at Alkabeera at 4m deep, and the average soft coral cover at all sites was 19.2%.

Latitude 20°

The highest hard coral cover was 52.5% at Alleeth in shallow transects. The average hard live hard coral in all transects was 44.4%. The highest soft coral cover was 32.0%, and the average of all transects was 17.5%.

Yemen

Latitude 15°

The highest hard coral cover along the Yemeni Red Sea Coast was 40.5% at Tekfash. The average live hard coral cover at all sites was 26.2%. The highest soft coral was 0.3% at Tekfash. The average soft coral cover at all sites was 0.1%.

Djibouti

The below sites were in the Gulf of Aden.

Latitude 12°

The highest hard coral cover was 32.5% recorded at Gehere in shallow transects. The average hard live coral cover at all sites was 23.8%. The highest soft coral cover was 17.5% recorded at Gehere in shallow transects. The average of soft coral cover at all sites was 15.8%.

Latitude 11°

The highest live hard coral cover was 71.0% at Tadjoura in shallow transects. The lowest hard live coral cover was 14.0% at Maskali in shallow transects. The highest soft coral cover was 2.5% at Musha. The average soft coral cover at all transects was 3.4%.

The overall mean percentage cover for both hard and soft coral (HC and SC combined) from highest to lowest was as follows: The highest was 61.9% total coral cover at latitude 20° along the Saudi Arabia coast, then 48.2% at latitude 27° along the Egyptian coast, 44.1 and 39.7 at latitude 11 and 12 ° respectively, 33.3% at latitude 29° along the Jordanian coast, 31.6 at Latitude 21 at Saudi Arabia coast, 26.3% at latitude 15° at the Yemeni coast, and the lowest combined total coral cover was 16.4% at latitude 22° along the Saudi Arabia coast.

Fish assemblages and community indices

Dominant taxa and fish community structure

Jordan

Latitude 29°

A total of 29,485 fishes were counted along the 18 transects examined at latitude 29°. The mean fish abundance ranged from 475 individuals per transect on the Tourist Camp reef at 5 m depth, to 3,117 individuals per transect on the Visitor Center reef at 5 m depth. The mean fish abundance across all transects was 1,638 individuals per transect. Of the 50 fish species considered, only 35 were observed at Jordanian

sites. The number of species observed ranged from 23 at 10m depth at the Tourist Camp, to 30 at 5m depth at the Marine Science Station, with an average of 19.6 species per transect (Fig. 3). In terms of relative abundance (RA) on Jordanian reefs, the 5 most abundant fish species examined was the Sea goldie, *Pseudanthias squamipinnis* (Peters, 1855) (RA= 40.7%), followed by Blue green damselfish, *Chromis viridis* (Cuvier, 1830) (RA= 27.5%), Whitetail dascyllus, *Dascyllus aruanus* (Linnaeus, 1758) (RA= 7.7%), Red Sea eightline flasher, *Paracheilinus octotaenia* Fourmanoir, 1955 in Roux-Estève and Fourmanoir 1955 (RA=7.3%), and Marginate dascyllus, *Dascyllus marginatus* (Rüppell, 1829) (RA= 6.8%). Together, these five species made up 90% of the abundance of the 50 fish species examined (Table 2).

In terms of frequency of appearance, the most common species were *P. squamipinnis*, *D. aruanus*, *D. marginatus*, Twoband anemonefish, *Amphiprion bicinctus* Rüppell, 1830, Eritrean butterflyfish *Chaetodon paucifasciatus* Ahl, 1923 (100% each), *C. viridis*, Fourline wrasse, *Larabicus quadrilineatus* (Rüppell, 1835), Green birdmouth wrasse, *Gomphosus caeruleus* Lacepède, 1801, and Yellowbreasted wrasse, *Anampses twistii* Bleeker, 1856 (94.4% each) (Table 3).

Egypt

Latitude 27°

A total of 196,379 fish individuals were counted along 32 transects which were examined at the latitude 27°. The mean abundance ranged from 310 individuals at Mahmoudat at 10 m depth, to 13,358 individuals per transect at Fanar Al-Dolphin at 5m depth. The mean fish abundance of all transects was 6,334 individuals per transect. Of the 50 fish species considered, only 43 were reported from Egyptian sites. The number of species observed ranged from 26 at Mahmoudat (10 m depth) to 34 at Al-Noksh (9 m depth), with a mean of 20.6 species per transect (Fig. 3).

In terms of relative abundance (RA) on Egyptian reefs, the most abundant species was *P. squamipinnis* (RA= 84.6%), followed by *C. viridis* (RA= 10.4%); these two species made up 95% of all the fishes recorded in Egypt (Table 2).

In terms of frequency of appearance (FA), the most common species was, Bluestreak cleaner wrasse *Labroides dimidiatus* (Valenciennes, 1839 in Cuvier and Valenciennes 1839) at 94.%, followed by Blacktail butterflyfish, *Chaetodon austriacus* Rüppell, 1836 and Klunzinger's wrasse, *Thalassoma rueppellii* (Klunzinger, 1871) (90%, each); other common species were *G. caeruleus*, Threadfin butterflyfish, *Chaetodon auriga* Forsskål, 1775 (87%, each), Blackside hawkfish, *Paracirrhites forsteri* (Schneider, 1801 in Bloch and Schneider 1801) (84%), and *C. paucifasciatus* (81%) (Table 3).

Saudi Arabia

Latitude 22°

A total of 1,380 fishes were counted along the 6 transects performed in Saudi Arabia at latitude 22°N. Fish abundance ranged from 145 individuals per transect in Bostek/Thoal at 10 m deep, to 297 individuals per transect in Bostek/Thoal at 10 m deep. The mean fish abundance in all transects was 230 fish per transect. Of the 50

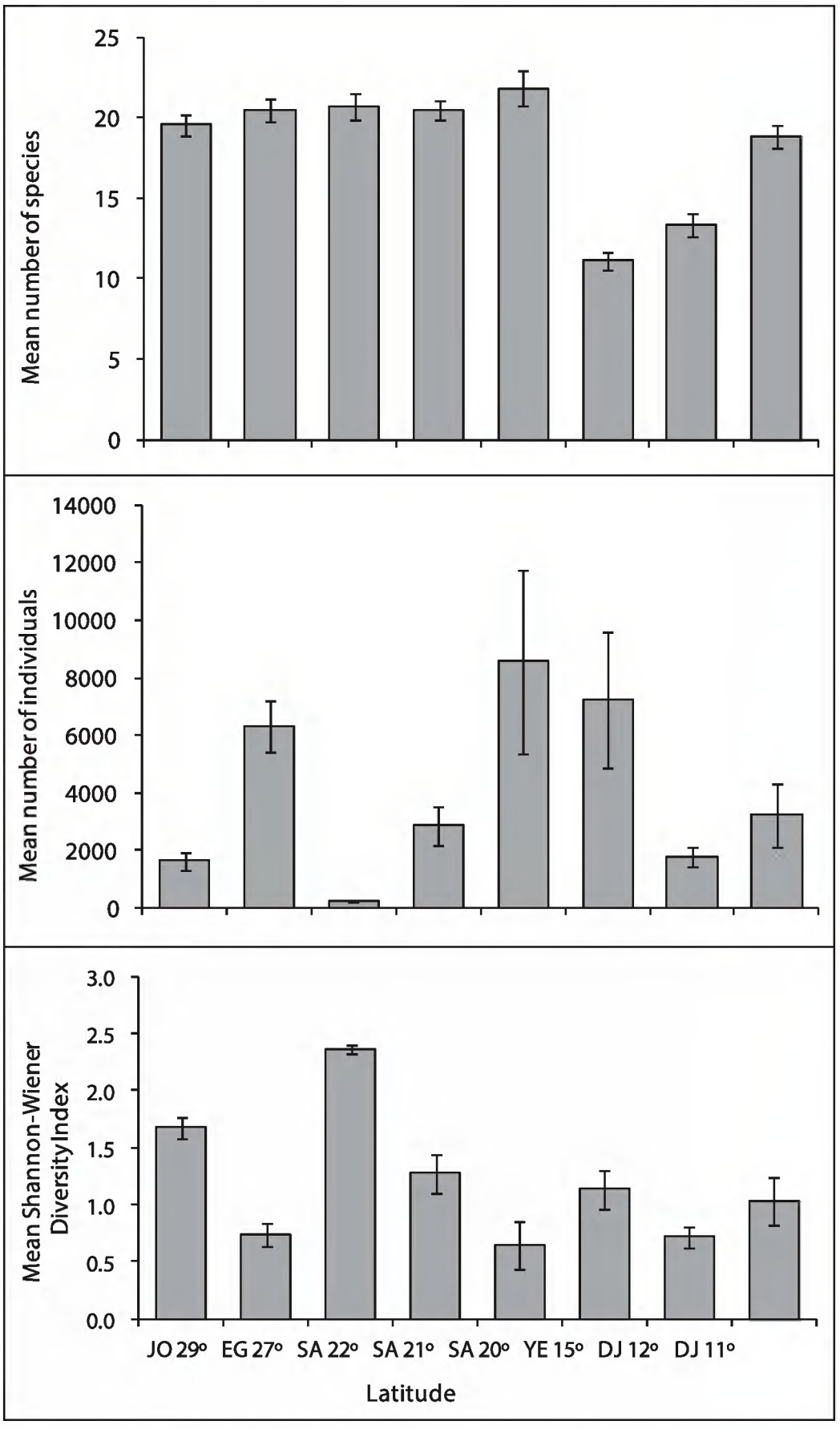

Figure 3. Mean number of fish species, mean number of individuals, and mean Shannon-Wiener Diversity Index in coral reef along the Jordan latitude 29°; Egypt latitude 27°; Saudi Arabia latitude 22, 21, 20°; Yemen 15° and Djibouti latitude 12, 11°.

species considered, only 35 were reported from this latitude, with a mean of 20.7 species per transect (Fig. 3).

In terms of relative abundance (RA), the most abundant fish species was *P. sqamipinnis* (RA= 16. 7%), followed by Sohal surgeonfish *Acanthurus sohal* (Forsskål, 1775) (RA= 12.4%), *L. quadrilineatus* (RA= 12.3), *G. caeruleus* (RA= 6.9), and Sunrise dot-

Table 2. Relative abundance in % of fish individuals per 500m² transect along reefs at JO= Jordan latitude 29°; EG=Egypt latitude 27°; SA=Saudi Arabia latitude 22, 21, 20°; YE=Yemen 15° and DJ=Djibouti latitude 12, 11°. (TRA indicates total relative abundance per family).

Fish scientific name	Fish common name	JO 29°	EG 27°	SA 22°	SA 21°	SA 20°	YE 15°	DJ 12°	DJ 11°	Total RA
Scorpaenidae										0,01
Pterois miles	Devil firefish	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,00
Pterois radiata	Radial firefish	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,01
Serranidae										34,71
Pseudanthias squamipinnis	Sea goldie	40,7	84,6	16,7	3,9	1,5	0,0	0,0	0,0	34,71
Pseudochromidae										0,28
Pseudochromis flavivertex	Sunrise dottyback	0,0	0,0	6,7	0,0	0,0	0,0	0,0	0,0	0,03
Pseudochromis fridmani	Orchid dottyback	0,8	0,4	0,9	0,2	0,1	0,0	0,0	0,0	0,23
Pseudochromis springeri	Blue-striped dottyback	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,02
Chaetodontidae										0,96
Chaetodon auriga	Threadfin butterflyfish	0,0	0,2	1,2	0,1	0,0	0,0	0,0	0,0	0,10
Chaetodon austriacus	Blacktail butterflyfish	0,5	0,2	2,3	0,2	0,0	0,0	0,0	0,0	0,13
Chaetodon fasciatus	Diagonal butterflyfish	0,1	0,1	1,3	0,1	0,0	0,0	0,0	0,1	0,06
Chaetodon larvatus	Hooded butterflyfish	0,0	0,0	1,2	0,1	0,2	0,8	0,2	0,4	0,27
Chaetodon lineolatus	Lined butterflyfish	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,00
Chaetodon melannotus	Blackback butterflyfish	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,03
Chaetodon melapterus	Arabian butterflyfish	0,0	0,0	0,0	0,0	0,0	0,0	0,4	0,2	0,02
Chaetodon mesoleucos	White-face butterflyfish	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,01
Chaetodon paucifasciatus	Eritrean butterflyfish	1,5	0,1	0,0	0,1	0,0	0,0	0,0	0,0	0,14
Chaetodon semilarvatus	Bluecheek butterflyfish	0,0	0,0	0,1	0,0	0,0	0,0	0,1	0,1	0,03
Chaetodon trifascialis	Chevron butterflyfish	0,0	0,1	0,0	0,0	0,0	0,0	0,1	0,1	0,07
Chaetodon vagabundus	Vagabond butterflyfish	0,0	0,0	0,0	0,0	0,0	0,0	0,3	0,1	0,01
Heniochus acuminatus	Pennant coralfish	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,00
Heniochus intermedius	Red Sea bannerfish	0,1	0,0	3,4	0,1	0,0	0,1	0,1	0,3	0,10
Pomacanthidae										0,18
Pomacanthus asfur	Arabian angelfish	0,0	0,0	1,7	0,0	0,0	0,1	0,1	0,1	0,06
Pomacanthus imperator	Emperor angelfish	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,00
Pomacanthus maculosus	Yellowbar angelfish	0,0	0,0	0,5	0,0	0,0	0,3	0,1	0,1	0,08
Pygoplites diacanthus	Regal angelfish	0,0	0,0	0,7	0,1	0,0	0,0	0,0	0,1	0,04
Pomacentridae										59,39
Amphiprion bicinctus	Twoband anemonefish	1,5	0,0	0,4	0,0	0,0	0,0	0,0	0,0	0,12
Chromis viridis	Blue green damselfish	27,5	10,4	0,0	73,9	92,3	88,8	83,8	90,8	54,40
Dascyllus aruanus	Whitetail dascyllus	7,7	0,2	0,6	17,3	0,1	0,3	0,0	0,4	2,61
Dascyllus marginatus	Marginate dascyllus	6,8	0,3	0,0	0,0	0,1	5,8	0,0	0,1	1,95
Dascyllus trimaculatus	Threespot dascyllus	0,4	0,0	0,0	0,1	0,1	1,0	0,0	0,0	0,30
Cirrhitidae										
Paracirrhites forsteri	Blackside hawkfish	0,0	0,1	0,3	0,3	0,0	0,0	0,0	0,0	0,08
Labridae										3,45
Anampses twistii	Yellowbreasted wrasse	0,6	0,1	0,5	0,1	0,0	0,0	0,0	0,0	0,09
Bodianus anthioides	Lyretail hogfish	0,1	0,0	0,4	0,0	0,0	0,0	0,0	0,0	0,02
Cheilinus lunulatus	Broomtail wrasse	0,0	0,0	1,3	0,0	0,0	0,0	0,0	0,0	0,04
Coris aygula	Clown coris	0,0	0,1	0,1	0,0	0,0	0,0	0,0	0,0	0,03
Gomphosus caeruleus	Green birdmouth wrasse	0,5	0,2	6,9	0,6	0,2	0,0	1,2	0,5	0,26
Labroides dimidiatus	Bluestreak cleaner wrasse	0,1	0,2	3,6	0,2	0,0	0,0	0,2	0,1	0,12

Fish scientific name	Fish common name	JO 29°	EG 27°	SA 22°	SA 21°	SA 20°	YE 15°	DJ 12°	DJ 11°	Total RA
Larabicus quadrilineatus	Fourline wrasse	0,4	0,1	12,3	0,2	0,4	1,6	4,1	1,7	0,74
Novaculichthys taeniourus	Rockmover wrasse	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,00
Paracheilinus octotaenia	Red Sea eightline flasher	7,3	0,3	1,1	0,0	3,9	0,1	0,0	0,7	0,98
Thalassoma rueppellii	Klunzinger's wrasse	2,6	1,2	6,1	0,7	0,2	0,0	0,0	0,0	0,72
Thalassoma lunare	Moon wrasse	0,0	0,0	5,6	0,2	0,2	0,6	7,6	1,5	0,45
Acanthuridae										0,88
Acanthurus sohal	Sohal surgeonfish	0,0	0,7	12,4	0,3	0,3	0,2	0,4	0,5	0,43
Naso lituratus	Orangespine unicornfish	0,0	0,1	2,9	0,1	0,1	0,0	0,0	0,8	0,14
Zebrasoma veliferum	Sailfin tang	0,1	0,1	6,4	0,5	0,0	0,0	0,0	0,2	0,14
Zebrasoma xanthurum	Yellowtail tang	0,3	0,1	0,9	0,2	0,0	0,0	1,2	1,0	0,17
Balistidae										0,04
Balistapus undulatus	Orange-lined triggerfish	0,0	0,0	0,8	0,1	0,0	0,0	0,0	0,0	0,03
Balistoides viridescens	Titan triggerfish	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,00
Rhinecanthus assasi	Picasso triggerfish	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,01
Ostraciidae										0,00
Ostracion cubicus	Yellow boxfish	0,0	0,0	0,2	0,0	0,0	0,0	0,0	0,0	0,00
Tetraodontidae										0,01
Arothron diadematus	Masked puffer	0,0	0,0	0,4	0,0	0,0	0,0	0,0	0,0	0,01

tyback *Pseudochromis flavivertex* Rüppell, 1835 (RA=6.7), these five species accounted for 54.93 % of all fish species recorded from this latitude (Table 2).

In terms of frequency of appearance (FA), the most common species were Sailfin tang *Zebrasoma veliferum* (Bloch, 1795), Hooded butterflyfish *Chaetodon larvatus* Cuvier, 1831, *Heniochus intermedius* Steindachner, 1893, *L. dimidiatus*, *L. quadrilineatus* and *G. caeruleus* (FA= 100%, each) (Table 3).

Latitude 21°

A total of 60,096 fishes were counted along the 21 transects performed in Saudi Arabia at latitude 21°. Fish abundance ranged from 116 individuals per transect in Alkabeera site at 4 m deep to 9,480 individuals per transect in South Batch Bayada at 10 m deep. The mean fish abundance in all transects was 2861.7 individuals per transect. Of the 50 species considered, only 40 were reported from this latitude, with a mean of 20.5 species per transect (Fig. 3).

In terms of relative abundance (RA), the most abundant fish species was *C. viridis* (RA=73.9%), followed by *D. aruanus* (RA=17.3%), and *P. sqamipinnis* (RA= 3.9%). These three species accounted 95.04 % of all fish species recorded from this latitude (Table 2).

In terms of frequency of appearance (FA), the most common species were *G. caeruleus* and *L. dimidiatus*, (FA= 100%, each) followed by *C. austriacus* (FA=95.5%), Diagonal butterflyfish *Chaetodon fasciatus* Forsskål, 1775 and *P. forsteri* (FA= 90.5%, each) (Table 3).

Latitude 20°

A total of 51,395 fishes were counted along the 6 transects performed in Saudi Arabia at latitude 20°. Fish abundance ranged from 1278 individuals per transect in Alleeth at

Table 3. Frequency of appearance in % of fish individuals per 500m² transect along reefs at JO= Jordan latitude 29°; EG=Egypt latitude 27°; SA=Saudi Arabia latitude 22, 21, 20°; YE=Yemen 15° and DJ=Djibouti latitude 12, 11°.

Fish species	JO 29°	EG 27°	SA 22°	SA 21°	SA 20°	YE 15°	DJ 12°	DJ 11°
Scorpaenidae								
Pterois miles	16,7	29,0	0,0	0,0	0,0	0,0	0,0	0,0
Pterois radiata	22,2	29,0	0,0	0,0	16,7	0,0	0,0	20,0
Serranidae								
Pseudanthias squamipinnis	100,0	80,6	50,0	33,3	83,3	0,0	0,0	0,0
Pseudochromidae								
Pseudochromis flavivertex	0,0	0,0	50,0	19,0	0,0	22,2	0,0	0,0
Pseudochromis fridmani	88,9	74,2	50,0	47,6	33,3	0,0	0,0	0,0
Pseudochromis springeri	61,1	25,8	0,0	0,0	0,0	0,0	0,0	0,0
Chaetodontidae								
Chaetodon auriga	11,1	87,1	83,3	66,7	33,3	0,0	0,0	0,0
Chaetodon austriacus	83,3	90,3	100,0	95,2	33,3	0,0	0,0	0,0
Chaetodon fasciatus	72,2	74,2	66,7	90,5	50,0	16,7	33,3	66,7
Chaetodon larvatus	0,0	3,2	100,0	76,2	100,0	100,0	100,0	100,0
Chaetodon lineolatus	0,0	9,7	16,7	4,8	0,0	0,0	0,0	0,0
Chaetodon melannotus	27,8	41,9	0,0	33,3	0,0	0,0	0,0	13,3
Chaetodon melapterus	0,0	0,0	0,0	0,0	0,0	0,0	100,0	93,3
Chaetodon mesoleucos	0,0	0,0	0,0	23,8	16,7	22,2	0,0	66,7
Chaetodon paucifasciatus	100,0	80,6	0,0	57,1	16,7	0,0	0,0	0,0
Chaetodon semilarvatus	0,0	45,2	16,7	33,3	50,0	50,0	33,3	73,3
Chaetodon trifascialis	11,1	74,2	0,0	52,4	0,0	5,6	33,3	33,3
Chaetodon vagabundus	0,0	0,0	0,0	0,0	0,0	0,0	100,0	73,3
Heniochus acuminatus	0,0	0,0	0,0	0,0	0,0	0,0	0,0	6,7
Heniochus intermedius	44,4	67,7	100,0	14,3	100,0	83,3	100,0	93,3
Pomacanthidae								
Pomacanthus asfur	0,0	0,0	66,7	0,0	83,3	94,4	33,3	86,7
Pomacanthus imperator	5,6	19,4	0,0	0,0	16,7	5,6	33,3	0,0
Pomacanthus maculosus	0,0	22,6	66,7	0,0	83,3	100,0	100,0	80,0
Pygoplites diacanthus	5,6	54,8	66,7	14,3	100,0	0,0	0,0	80,0
Pomacentridae								
Amphiprion bicinctus	100,0	45,2	33,3	47,6	83,3	11,1	0,0	26,7
Chromis viridis	94,4	54,8	0,0	71,4	100,0	55,6	100,0	93,3
Dascyllus aruanus	100,0	22,6	33,3	61,9	66,7	16,7	0,0	46,7
Dascyllus marginatus	100,0	19,4	0,0	0,0	33,3	50,0	0,0	20,0
Dascyllus trimaculatus	44,4	16,1	0,0	4,8	33,3	11,1	0,0	13,3
Cirrhitidae								
Paracirrhites forsteri	0,0	83,9	33,3	90,5	16,7	0,0	0,0	0,0
Labridae								
Anampses twistii	94,4	77,4	33,3	66,7	50,0	0,0	0,0	53,3
Bodianus anthioides	61,1	29,0	50,0	14,3	16,7	0,0	0,0	0,0
Cheilinus lunulatus	22,2	64,5	83,3	14,3	66,7	72,2	33,3	53,3
Coris aygula	27,8	67,7	16,7	14,3	0,0	5,6	0,0	0,0
Gomphosus caeruleus	94,4	87,1	100,0	100,0	100,0	22,2	100,0	93,3
Labroides dimidiatus	66,7	93,5	100,0	100,0	100,0	27,8	100,0	66,7
Larabicus quadrilineatus	94,4	74,2	100,0	76,2	100,0	100,0	100,0	100,0
Novaculichthys taeniourus	0,0	0,0	0,0	4,8	16,7	0,0	0,0	0,0

Fish species	JO 29°	EG 27°	SA 22°	SA 21°	SA 20°	YE 15°	DJ 12°	DJ 11°
Paracheilinus octotaenia	55,6	9,7	33,3	0,0	83,3	5,6	0,0	33,3
Thalassoma rueppellii	100,0	90,3	83,3	85,7	83,3	0,0	0,0	0,0
Thalassoma lunare	22,2	48,4	100,0	81,0	83,3	100,0	100,0	100,0
Acanthuridae								
Acanthurus sohal	0,0	32,3	66,7	71,4	100,0	50,0	66,7	53,3
Naso lituratus	5,6	41,9	50,0	71,4	50,0	5,6	0,0	6,7
Zebrasoma veliferum	44,4	48,4	100,0	47,6	83,3	44,4	0,0	86,7
Zebrasoma xanthurum	88,9	41,9	33,3	47,6	16,7	22,2	66,7	100,0
Balistidae								
Balistapus undulatus	50,0	29,0	83,3	76,2	50,0	0,0	0,0	40,0
Balistoides viridescens	0,0	3,2	33,3	14,3	16,7	0,0	0,0	13,3
Rhinecanthus assasi	0,0	19,4	0,0	42,9	16,7	5,6	0,0	0,0
Ostraciidae								
Ostracion cubicus	27,8	3,2	16,7	4,8	0,0	5,6	0,0	0,0
Tetraodontidae								
Arothron diadematus	11,1	32,3	66,7	19,0	16,7	0,0	0,0	0,0

10 m deep, to 20,038 individuals per transect in Alleeth at 5 m deep. The meanfish abundance of all transects was 8565.8 individuals per transect. Out of the 50 species considered, only 40 were reported from this latitude, with a mean of 21.8 species per transect (Fig. 3).

In terms of relative abundance (RA), the most abundant fish species was *C. viridis* (RA=92.32%), followed by *P. octotaenia* (RA=3.86%), and *P. sqamipinnis* (RA= 1.53%). These three species accounted for 97.71 % of all fish species recorded from this latitude (Table 2).

In terms of frequency of appearance (FA), the most common species were *A. sohal, C. larvatus, H. intermedius, G. caeruleus, L. dimidiatus, L. quadrilineatus,* Regal angelfish *Pygoplites diacanthus* (Boddaert, 1772) and *C. viridis* (FA= 100%, each) (Table 3).

Yemen

Latitude 15°

A total of 129,932 fishes were counted during the 18 transects that were performed at latitude 15°. The mean fish abundance ranged from 95 individuals per transect at Al-Murk at 5 m deep, to 24,906 individuals per transect at Quish at 4m depth. The average fish abundance calculated from all transects was 7,218 individuals per transect. Of the 50 ornamental fish species considered, only 28 were reported from the Yemeni sites. The number of species observed ranged from 11 at Al-Murk (4 m depth) to 18 at both Quish and Al-Badi Island (shallow depth), with a mean of 11.1 species per transect (Fig. 3).

In terms of relative abundance (RA), the most abundant species was *C. viridis*. This species accounted for 88.5% of the fish abundance recorded at Kamaran, 79.1% at Tekfash, 93.3% at Quish and 85.3% at Al-Badi.

The mean relative abundance for *C. viridis* in all transects was 88.8%. The second most abundant fish species was *D. marginatus* accounting for 4.1%, 14.1%, 3.1% and 8.7% of fish abundance from Kamaran, Tekfash, Quish and Al-Badi respectively. The mean relative fish abundance for *D. marginatus* in all transects was 5.8%. This was fol-

lowed by *L. quadrilineatus* (average 1.6%) and *C. larvatus* (average 0.8%). These four species made up 99% of the 28 fish species which were counted (Table 2).

In terms of frequency of appearance (FA), the most common fish species were Yellowbar angelfish *Pomacanthus maculosus* (Forsskål, 1775), Moon Wrasse *Thalassoma lunare* (Linnaeus, 1758), *L. quadrilineatus*, and *C. larvatus* (100%, each), followed by *Pomacanthus asfur* (Forsskål, 1775) (94.0%) and *H. intermedius* (83.3%) (Table 3).

Djibouti

Latitude 12°

A total of 5,368 fishes were counted in the 3 transects that were examined at latitude 12°. Fish abundance ranged from 1164 fishes in Gehere at 4 m depth, to 2408 in Gehere at 4 m depth. The mean fish abundance of all transects was 1789.3 individuals per transect. Of the 50 species considered, only 18 were reported from this latitude, with a mean of 13.3 species per transect (Fig 3).

In terms of relative abundance (RA), the most abundant fish species was *C. viridis* (RA=83.8%), followed by *T. lunare* (RA= 7.6%), and *L. quadrilineatus* (RA= 4.1%). These three species accounted 95.51 % of all fish species recorded from this latitude (Table 2).

In terms of frequency of appearance (FA), the most common species were *C. larvatus*, Arabian butterflyfish *Chaetodon melapterus* Guichenot, 1863, Vagaband butterflyfish *Chaetodon vagabundus* Linnaeus, 1758, *H. intermedius*, *G. caeruleus*, *L. dimidiatus*, *L. quadrilineatus*, *T. lunare*, *P. maculosus*, and *C. viridis* (100%, each) (Table 3).

Latitude 11°

A total of 48,488 fishes were counted along the 15 transects that were examined in Djibouti at latitude 11°. Fish abundance ranged from 181 fishes in Khor Ambado at 7 m depth, to 16,609 in Maskali at 5 m depth. The mean fish abundance of all transects was 3232.5 individuals per transect. Of the 50 species considered, only 33 were reported from this latitude, with a mean of 18.8 species per transect (Fig 3).

In terms of relative abundance (RA), the most abundant fish species was *C. viridis* (RA= 90.81%), followed by *L. quadrilineatus* (RA= 1.70%), and *T. lunare* (RA= 1.47%) (Table 2). These three species accounted for 93.98 % of all fish species recorded from this latitude.

In terms of frequency of appearance (FA), the most common species were Yellowtail tang *Zebrasoma xanthurum* (Blyth, 1852), *C. larvatus*, *L. quadrilineatus* and *T. lunare* (100%, each), followed by *C. melapterus*, *H. intermedius*, *G. caeruleus* and *C. viridis* (93.30%, each), see Table 3.

All Latitudes

A total of 522,523 fish individuals were counted in the 118 transects that were examined at all latitudes (Jordan 29°, Egypt 27°, Saudi Arabia 22°, 21° and 20°, Yemen 15°, Djibouti 12° and 11°). The mean fish abundance in all transects was 4428.2 ±87.26 individuals per transect.

In terms of relative abundance (RA), the most abundant fish species was *C. viridis* (RA=54.4%), followed by *P. squamipinnis* (RA= 34.7), *D. aruanus* (RA= 2.6%), *D. marginatus* (RA= 2.0), *P. octotaenia* (RA=1.0) and *T. rueppellii* (0.7%). These six species accounted for 95.47% of all fish species recorded during this study (Table 2). Number of species, number of individuals, and Shannon-Wiener diversity in sites along the Jordanian, Egyptian, Saudi Arabia, Yemeni and Djiboutian reefs are shown in Figure 3. Of the 50 fish species counted during this study, the highest number of species (S) was found at latitude 20° on Saudi Arabian reefs (S= 21.8), and the lowest at latitude 15° in Yemen (S= 11.11). The highest mean fish abundance was found on reefs at latitude 20° in Saudi Arabia (8565.8), followed by latitude 15° in Yemen (AA=7218), whereas the lowest number of individuals was found on reefs at latitude 22° in Saudi Arabia (AA= 230). The highest mean Shannon-Wiener diversity Index was found in Saudi Arabia at latitude 22° (H`= 2.4), followed latitude 29° in Jordan, whereas the lowest was found at latitude 20° in Saudi Arabia (H`= 0.6) (Fig. 3). Table 4 shows mean fish abundance for the 50 ornamental fish species at all latitudes.

Fish families

Figures 4, 5 and 6 illustrate differences in the mean fish abundance per 500 m^2 transect, according to latitudinal distribution among the 50 ornamental fish species. These belong mainly to the following fish families: [Fig. 4. I. Acanthuridae (4 species), II. Balistidae (3 species), III. Chaetodontidae (14 species), IV. Pomacanthidae (4 species)[; [Fig. 5. V. Pomacentridae (5 species), VI. Pseudochromidae (3 species), VII. Cirrhitidae (one species), VIII. Serranidae (one species) IX. Labridae (11 species)]; and Fig. 6. X. Scorpaenidae (2 species), XI. Ostraciidae (one species), XII. Tetraodontidae [(one species)] that are utilized by the aquarium trade in the region.

Acanthuridae (Surgeonfishes)

Of the 12 species of surgeonfish's reported from the Red Sea, only 4 species are important in the ornamental fish trade, therefore only *A. sohal,* Orangespine unicornfish *Naso lituratus* (Forster, 1801 in Bloch and Schneider 1801), *Z. veliferum* and *Z. xanthurum* were counted. *A. sohal* were abundant along Egyptian latitude 27° followed by Saudi Arabian latitude 22°. *N. lituratus* were abundant along the Djiboutian reefs at latitude 11° (Fig 4). *Z. veliferum* were abundant along the Saudi Arabian reefs at latitudes 22 and 21°. Whereas, *Z. xanthurum* were most abundant along the Djiboutian reefs at latitudes 11 and 12°. Triggerfishes had the lowest number of individuals.

Balistidae (Triggerfishes)

This family had the lowest number of individuals of all fish families examined here. Out of the 10 triggerfishes reported from the Red Sea, only Ornage-lined triggerfish *Balistapus undulatus* (Park, 1797), Titan triggerfish *Balistoides viridescens* (Bloch &

Table 4. Mean fish abundance in percentage (%, ± SE) per 500m² transect along reefs at JO= Jordan latitude 29°; EG=Egypt latitude 27°; SA=Saudi Arabia latitude 22, 21, 20°; YE=Yemen 15° and DJ=Djibouti latitude 12, 11°.

Fish species	JO 29°	EG 27°	SA 22°	SA 21°	SA 20°	YE 15°	DJ 12°	DJ 11°
Scorpaenidae								
Pterois miles	0.2 ±0.1	0.6 ±0.2	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0
Pterois radiata	0.4 ±0.2	0.5 ±0.1	0.0 ±0.0	0.0 ±0.0	0.2 ±0.2	0.0 ±0.0	0.0 ±0.0	0.3 ±0.2
Serranidae								
Pseudanthias squamipinnis	666.2 ±156.2	5356.2 ±896.0	38.3 ±21.2	111.4 ±51.4	130.8 ±59.6	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0
Pseudochromidae								
Pseudochromis flavivertex	0.0 ±0.0	0.0 ±0.0	15.3 ±7.1	0.5 ±0.3	0.0 ±0.0	3.3 ±1.8	0.0 ±0.0	0.0 ±0.0
Pseudochromis fridmani	13.3 ±2.9	26.1 ±8.3	2.0 ±0.9	4.7 ±1.5	7.8 ±6.5	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0
Pseudochromis springeri	2.3 ±0.6	2.5 ±1.8	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0
Chaetodontidae								
Chaetodon auriga	0.2±0.1	13.6 ±4.9	2.8 ±0.7	3.0 ±0.8	0.7 ±0.4	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0
Chaetodon austriacus	8.2 ±1.6	10.7 ±1.5	5.3 ±1.3	6.5 ±0.8	2.2 ±1.4	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0
Chaetodon fasciatus	2.2 ±0.6	3.6 ±0.7	3.0 ±1.3	3.1 ±0.5	0.8 ±0.4	0.4 ±0.3	0.7 ±0.7	2.7 ±0.7
Chaetodon larvatus	0.0 ±0.0	0.1 ±0.1	2.7 ±0.7	1.9 ±0.4	17.5 ±4.3	58.1 ±12.2	3.3 ±0.7	13.3 ±2.6
Chaetodon lineolatus	0.0 ±0.0	0.2 ±0.1	0.3 ±0.3	0.1 ±0.1	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0
Chaetodon melannotus	0.6 ±0.2	3.1 ±0.9	0.0 ±0.0	2.2 ±1.4	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0	0.3 ±0.2
Chaetodon melapterus	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0	7.3 ±1.2	7.1 ±1.3
Chaetodon mesoleucos	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0	0.6 ±0.2	0.3 ±0.3	0.9 ±0.6	0.0 ±0.0	1.7 ±0.4
Chaetodon paucifasciatus	24.5 ±2.3	7.2 ±1.2	0.0 ±0.0	2.3 ±0.6	0.3 ±0.3	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0
Chaetodon semilarvatus	0.0 ±0.0	1.5 ±0.4	0.2 ±0.2	0.7 ±0.2	1.8 ±0.9	2.1 ±0.8	1.3 ±1.3	2.5 ±0.6
Chaetodon trifascialis	0.2 ±0.1	9.2 ±1.5	0.0 ±0.0	1.0 ±0.3	0.0 ±0.0	0.6 ±0.6	1.3 ±1.3	2.2 ±1.0
Chaetodon vagabundus	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0	6.0 ±1.2	2.3 ±0.6
Heniochus acuminatus	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0	0.1 ±0.1
Heniochus intermedius	1.1 ±0.3	2.8 ±0.4	7.8 ±2.00	2.6 ±0.4	3.5 ±0.6	8.2 ±2.1	2.7 ±0.7	9.6 ±3.9
Pomacanthidae								
Pomacanthus asfur	0.0 ±0.0	0.0 ±0.0	3.8 ±1.5	0.0 ±0.0	3.7 ±1.1	9.8 ±1.8	1.7 ±1.7	4.2 ±0.7

Fish species	JO 29°	EG 27°	SA 22°	SA 21°	SA 20°	YE 15°	DJ 12°	DJ 11°
Pomacanthus imperator	0.1 ±0.1	0.3 ±0.1	0.0 ±0.0	0.0 ±0.0	0.2 ±0.2	0.1 ±0.1	0.3 ±0.3	0.0 ±0.0
Pomacanthus maculosus	0.0 ±0.0	0.4 ±0.1	1.2 ±0.5	0.4 ±0.4	1.7 ±0.5	20.2 ±3.9	2.0 ±0.6	2.2 ±0.6
Pygoplites diacanthus	0.2 ±0.2	1.3 ±0.3	1.5 ±0.8	4.3 ±0.8	2.3 ±0.3	0.0 ±0.0	0.0 ±0.0	4.1 ±0.9
Pomacentridae								
Amphiprion bicinctus	25.2 ±2.0	2.8 ±1.4	0.8 ±0.5	1.2 ±0.3	1.7 ±0.6	0.1 ±0.1	0.0 ±0.0	1.3 ±0.7
Chromis viridis	450.0 ±158.6	657.6 ±209.2	0.0 ±0.0	2114.3 ±582.7	7908.3 ±3192.2	6411.1 ±2248.9	1500.0 ±346.4	2935.3 ±1093.6
Dascyllus aruanus	125.7 ±32.7	10.7 ±5.00	1.3 ±0.9	494.o ±185.3	10.3 ±7.8	24.0 ±17.8	0.0 ±0.0	12.53 ±6.2
Dascyllus marginatus	111.8 ±24.2	17.4 ±7.8	0.0 ±0.0	0.0 ±0.0	5.8 ±4.2	420.9 ±124.2	0.0 ±0.0	2.7 ±1.5
Dascyllus trimaculatus	7.2 ±2.9	0.8 ±0.4	0.0 ±0.0	1.7 ±1.2	9.5 ±7.1	72.9 ±72.8	0.0 ±0.0	1.3 ±1.1
Cirrhitidae								
Paracirrhites forsteri	0.0 ±0.0	6.4 ±1.1	0.7 ±0.4	9.5 ±1.7	0.2 ±0.7	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0
Labridae								
Anampses twistii	9.8 ±1.7	7.0 ±1.1	1.2 ±0.8	2.7 ±0.6	1.2 ±0.7	0.0 ±0.0	0.0 ±0.0	1.0 ±0.3
Bodianus anthioides	2.0 ±0.6	1.6 ±0.6	1.0 ±0.5	0.2 ±0.1	0.8 ±0.8	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0
Cheilinus lunulatus	0.3 ±0.2	2.1 ±0.4	3.0 ±1.1	0.4 ±0.3	1.5 ±0.6	3.5 ±0.1	0.3 ±0.3	1.6 ±0.9
Coris aygula	0.3 ±0.1	4.7 ±1.1	0.3 ±0.3	0.2 ±0.1	0.0 ±0.0	0.1 ±0.1	0.0 ±0.0	0.0 ±0.0
Gomphosus caeruleus	8.3 ±1.6	13.1 ±2.1	15.8 ±1.7	15.8 ±1.9	14.3 ±3.7	0.4 ±0.2	21.0 ±10.6	15.7 ±3.5
Labroides dimidiatus	1.7 ±0.5	11.0 ±1.5	8.3 ±1.6	6.4 ±0.7	4. 0 ±0.7	0.4 ±0.2	3.0 ±1.0	2.9 ±0.9
Larabicus quadrilineatus	6.8 ±1.1	3.9 ±0.7	28.3 ±7.2	6.0 ±1.7	34.8 ±4.5	114.6 ±21.7	73.7 ±25.7	55.1 ±6 .0
Novaculichthys taeniourus	0.00 ±0.00	0.00 ±0.00	0.00 ±0.00	0.90 ±0.90	0.17 ±0.17	0.00 ±0.00	0.00 ±0.00	0.00 ±0.00
Paracheilinus octotaenia	119.9 ±44.8	17.1 ±9.6	2.5 ±1.7	0.0 ±0.0	330.8 ±144.00	5.6 ±5.6	0.0 ±0.0	21.1 ±9.7
Thalassoma rueppellii	42.0 ±4.4	78.7 ±23.5	14.0 ±3.7	19.8 ±3.9	13.7 ±5.9	0.0 ±0.0	0.0 ±0.0	0.0 ±0.0
Thalassoma lunare	0.8 ±0.4	2.6 ±0.7	12.8 ±3.2	6.3 ±1.3	17.7 ±7.7	44.4 ±8.2	135.3 ±5.4	47.6 ±8.4
Acanthuridae								
Acanthurus sohal	0.0 ±0.0	41.4 ±21.7	28.5 ±13.5	8.9 ±1.8	26.5 ±8.3	10.8 ±5.3	8.0 ±4.2	15.0 ±5.8
Naso lituratus	0.1 ±0.1	4.2 ±1.7	6.7 ±4.1	4.1 ±0.9	4.3 ±2.4	1.4 ±1.4	0.0 ±0.0	27.3 ±27.3
Zebrasoma veliferum	1.1 ±0.3	4.9 ±1.5	14.8 ±8.3	13.00 ±9.5	4.2 ±1.9	3.1 ±1.1	0.0 ±0.0	6.6 ±1.3
Zebrasoma xanthurum	4.1 ±0.5	3.7 ±1.5	2.0 ±1.6	6.3 ±4.0	0.3 ±0.3	1.3 ±0.7	21.3 ±13.7	32.1 ±6.4

Fish species	JO 29°	EG 27°	SA 22°	SA 21°	SA 20°	YE 15°	DJ 12°	DJ 11°
Balistidae								
Balistapus undulatus	0.8 ±0.3	0.9 ±0.3	1.8 ±0.7	2.9 ±0.6	1.2 ±0.7	0.0 ±0.0	0.0 ±0.0	0.7 ±0.3
Balistoides viridescens	0.0 ±0.0	0.0 ±0.0	0.3 ±0.2	0.1 ±0.1	0.3 ±0.3	0.0 ±0.0	0.0 ±0.0	0.1 ±0.1
Rhinecanthus assasi	0.0 ±0.0	0.5 ±0.2	0.0 ±0.0	1.4 ±0.4	0.2 ±0.2	0.1 ±0.1	0.0 ±0.0	0.00 ±0.00
Ostraciidae								
Ostracion cubicus	0.5 ±0.3	0.0 ±0.0	0.5 ±0.5	0.1 ±0.1	0.0 ±0.0	0.1 ±0.1	0.0 ±0.0	0.00 ±0.00
Tetraodontidae								
Arothron diadematus	0.1 ±0.1	2.1 ±1.3	0.8 ±0.3	0.2 ±0.1	0.2 ±0.2	0.0 ±0.0	0.0 ±0.0	0.00 ±0.00

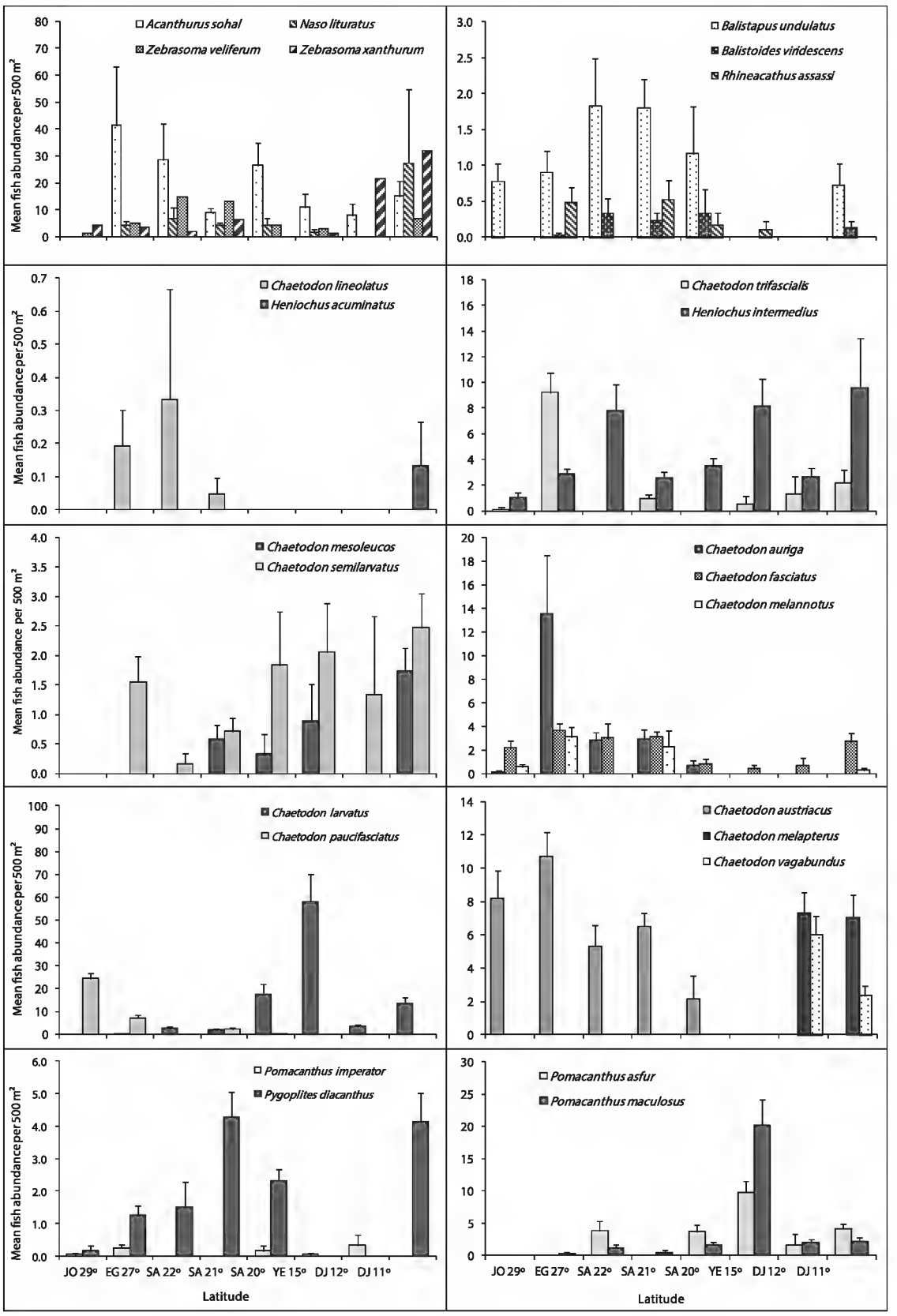

Figure 4. Differences in mean fish abundance per 500 m² transect according to latitudinal distribution for the families: Acanthuridae (*A. sohal, N. lituratus, Z. veliferum* and *Z. xanthurum)*, Balistidae (*B. undulates, B. viridescens*, and *R. assassin)*, Chaetodontidae (*C. lineolatus, H. acuminatus, C. mesoleucos, C. semilarvatus, C. auriga, C. fasciatus, C. melannotus, C. larvatus, C. paucifasciatus, C. austiacus, C. trifascialis, H. intermedius, C. melapterus*, and *C. vagabundus*), and Pomacanthidae (*P. asfur, P. imperator, P. maculosus* and *P. diacanthus*).

Schneider, 1801), and Picasso triggerfish *Rhinecanthus assasi* (Forsskål, 1775) were counted due to their importance in the aquarium trade. Geographical trends indicated that *B. undulates* and *B. viridescens* were more abundant along the Saudi Arabian reefs at Latiudes 22, 21 and 20° but *R. assassi* did not show any clear geographical trend (Fig. 4).

Chaetodontidae (Butterflyfishes)

Out of the 17 butterflyfishes known from the Red Sea, this study indicates the presence of 14 species. Geographical trends were observed in almost all butterflyfish species (Fig. 4). *C. austiacus* and *C. paucifasciatus* were most abundant along the reefs at latitudes 29 and 27°. These two species were not recorded in latitudes 15, 12 and 11°. On the other hand, *C. auriga*, *C. fasciatus* and *Chaetodon lineolatus* Cuvier, 1831 in Cuvier and Valenciennes were most abundant along the Egyptian and Saudi Arabia at latitudes 27, 22, and 21°. *C. larvatus* was most abundant along the Saudi Arabia and Yemen reefs at latitudes 20 and 15°. There were 3 butterflyfish species *C. melapterus*, *C. vagabundus*, and Pennant coralfish *Heniochus acuminatus* (Linnaeus, 1758) exist only at the Djiboutian reefs at latitudes 12 and 11°. The distributional pattern for all butterflyfish species is shown in Fig. 4.

Pomacanthidae (Angelfishes)

This family had the second lowest number of individuals of the fish families examined here. Out of the 7 species of angelfish recorded from the Red Sea, only 4 species (*P. asfur*, Emperor angelfish, *Pomacanthus imperator* (Bloch, 1787), *P. maculosus,* and *P. diacanthus*) that are used in the aquarium fish trade in the Red Sea were found. Latitude 15° exhibited the highest number of individuals for angelfish species, particularly for *P. asfur* and *P. maculosus*. Whereas, the reefs at the latitude 29° had the lowest number of individuals. Geographical trends were clear for some species like *P. asfur* which is the most abundant angelfish at the latitudes 15° but did not reach the northern Red Sea at the reefs between latitudes 29 and 27°. The distributional pattern for angelfish species is shown in Fig. 4.

Psudochromidae (Dottybacks)

Out of the 12 dottybacks fishes known from the Red Sea, only 3 species of importance in ornamental fish trade were counted. The 3 of them were not reported along the Djiboutian reefs. Bluestriped dottyback *Pseudochromis springeri* Lubbock, 1975 preferred the north, and it was found only along the Jordanian and Egyptian reefs at latitudes 29 and 27°. Whereas, Orchid dottyback *Pseudochromis fridmani* Klausewitz, 1968 extended to reach reefs at latitude 15°. The distributional pattern for Dottybacks is shown in Fig. 4.

Pomacentridae (Damselfishes)

Damselfishes had the highest number of individuals at all studied sites. Out of 35 damselfishes known from the Red Sea, only 5 species that are mostly used in the aquarium trade in the region were counted. *C. viridis* was the most dominant species of the damselfish family on Red Sea reefs. Geographical distribution of the clownfish *A. bicinctus* revealed that it prefers the Jordanian and Egyptian reefs at latitude 29° and 27°. The distributional pattern for damselfishes is shown in Fig. 5.

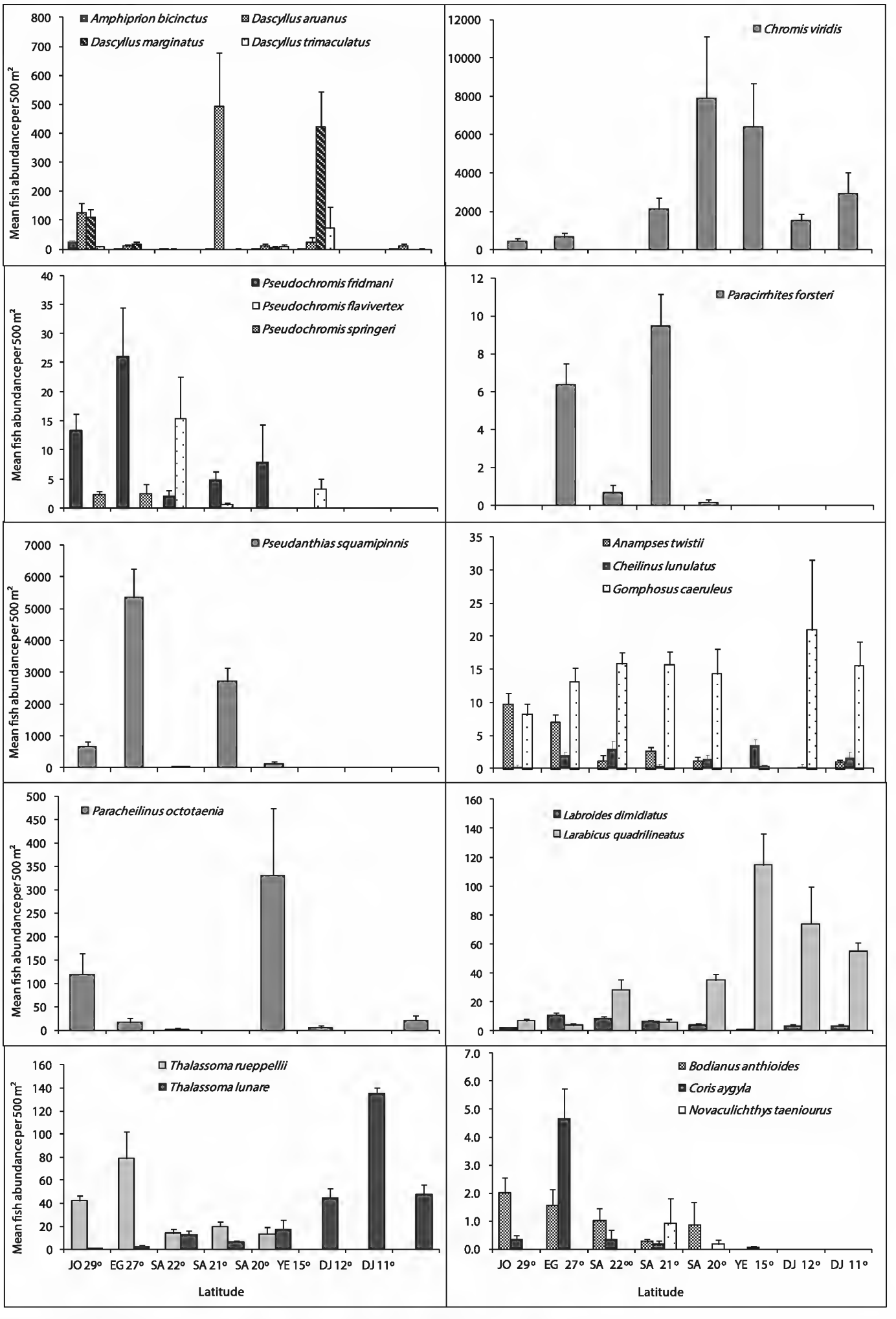

Figure 5. Differences in mean fish abundance per 500 m² transect according to latitudinal distribution for the fish species belonging mainly to families: Pomacentridae (*A. bicinctus, D. aruanus, D. marginatus, D. trimaculatus*, and *C. viridis*), Pseudochromidae (*P. fridmani, P. flavivertex* and *P. springeri*), Cirrhitidae (*P. forsteri*), Serranidae (*P. squamipinnis*), and Labridae (*A. twistii, C. lunulatus, G. caeruleus, P. octotaenia, L. dimidiatus, L. qudrilineatus, T. rueppellii, T. lunare, B. anthioides, C. aygula* and *N. taeniourus*).

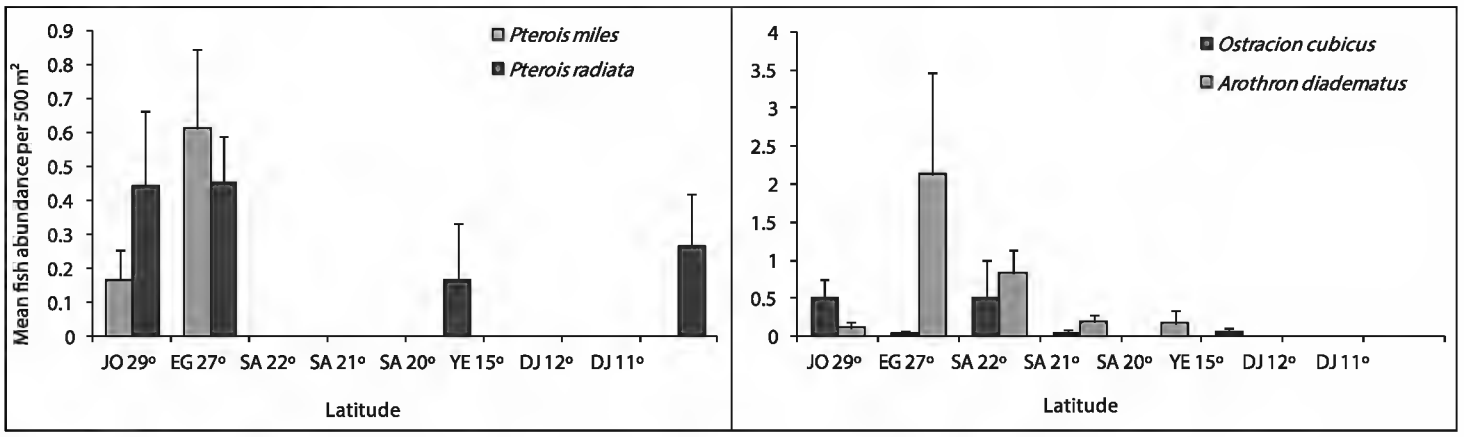

Figure 6. Differences in mean fish abundance per 500 m² transect according to latitudinal distribution for the fish species belonging to the family Scorpaeinidae (*P. miles, P. radiata*), Ostraciidae (*O. cubicus*), and Tetraodontidae (*A. diadematus*).

Labridae (Wrasses)

Out of the 64 wrasses reported from the Red Sea, only 11 species that are used mostly in the aquarium fish trade were counted. *T. rueppellii*, *Bodianus anthioides* (Bennett, 1832), *Coris aygula* Lacepède, 1801 and *A. twistii* were most abundant along the reefs in latitudes 29 and 27°; they were rare or not recorded along the Yemeni and Djiboutian reefs at latitudes 15, 12 and 11°. However, *T. rueppellii* and *B. anthioides* were restricted to the northern and central Red Sea. On the other hand, *T. lunare* was most abundant in the south at latitudes 15, 12 and 11°. The cleaner wrasse *L. dimidiatus* was most abundant along the reefs in latitudes 27, 22° and *L. qudrilineatus* on the other side was most abundant along the reefs at latitudes 15, 12 and 11°. The distributional pattern for wrasses is presented in Fig. 5.

Serranidae (Groupers)

Only *P. squampinnis* belonging to the subfamily Anthininae was counted during this study. The counts indicated that this species was most abundant along the reefs at latitudes 27 and 29° respectively and it was not reported from the Yemeni and Djiboutian reefs at latitudes 15, 12 and 11° (Fig. 5).

Cirrhitidae (Hawkfishes)

P. forsteri did not show a geographical trend in its distribution, except that it was not recorded in reefs at latitudes 29°, 15, 12 and 11° (Fig. 5).

Ostracidae (Boxfishes)

The distributional patterns for the boxfish, *Ostracion cubicus* Linnaeus, 1758, are shown in Fig. 6. It was abundant along the Jordanian reefs at latitude 29° and Saudi Arabia 22° reefs. It was either rare or not reported in other studied sites.

Tetraodontidae (Pufferfishes)

Arothron diadematus (Rüppell, 1829) is of importance in the fish aquarium trade in the region, and the number of individuals were very low. This species was not reported in the southern Red Sea and Gulf of Aden (Fig. 6).

Scorpaenidae (Scorpionfishes)

Two species *Pterois miles* (Bennett, 1828) and *Pterois radiata* Cuvier, 1829 in Cuvier and Valenciennes 1829 belonging to this family were counted; *Pterois miles* was reported only on Jordanian and Egyptian reefs. Whereas, *P. radiata* reached to Djiboutian waters, but both species were present in very low numbers. The distributional pattern for both species is shown in Fig. 6.

Correlation of fish community pattern with benthic habitat

The simple regression procedure of the Stat View software was used to correlate the fish community patterns such as species richness, average fish abundance (N), and Shannon-Wiener Index (H`) to benthic habitat (Table 5). The maximum regression correlation between hard coral cover and fish species richness (r=0.9060) was at reefs in latitude 12° followed by latitude 22°. Whereas, the strongest correlation with average fish abundance (r=0.554) was at reefs in latitude 20°, followed by latitude 15°. Reefs in latitude 20° also exhibited the highest regression correlation with Shannon-Wiener

Table 5. Regression correlation (r) analysis of fish community pattern vs. hard coral (simple regression); mean fish abundance (N), species richness (number of species) and Shannon-Wiener Index (H`) at reefs at various latitudes along the Red Sea and Gulf of Aden * if p <0.05 significant correlation.

Latitude	Number of species	Number of Individuals	Shannon-Wiener diversity H′
29°	**0,257**	**0,378**	**0,219**
	p=0.305	*p=0.121*	p=0.385
27°	**0,395**	**0,354**	**0,451**
	p=0.028*	*p*=0.051	*p*=0.01*
22°	**0,179**	**0,473**	**0,118**
	p=0.733	*p*=0.343	*p*=0.807
21°	**0,415**	**0,447**	**0,2**
	p=0.613	*p*=0.042*	*p*=0.385
20°	**0,767**	**0,554**	**0,758**
	p=0.075	*p*=0.254	*p*=0.080
15°	**0,663**	**0,221**	**0,584**
	p=0.003*	*p*=0.375	*p*=0.011
12°	**0,906**	**0,431**	**0,448**
	p=0.278	*p*=0.716	*p*=0.711
11°	**0,02**	**0,305**	**0,071**
	p=0.944	*p*=0.268	*p*=0.793

Table 6. Regression correlation (r) analysis of fish community pattern vs. soft coral (simple regression); mean fish abundance (N), species richness (number of species) and Shannon-Wiener Index (H`) at reefs at various latitudes along the Red Sea and Gulf of Aden. * if p <0.05 significant correlation.

Latitude	Number of species	Number of Individuals	Shannon-Wiener diversity H′
29°	**0,329**	**0,311**	**0,445**
	p=0.183	p=0.209	p=0.064
27°	**0,122**	**0,355**	**0,564**
	p=0.509	p=0.050*	p=0.001*
22°	**0,338**	**0,276**	**0,484**
	p=0.513	p=0.598	p=0.330
21°	**0,342**	**0,475**	**0,422**
	p=0.128	p=0.030	p=0.0.056
20°	**0,237**	**0,095**	**0,758**
	p=0.650	p=0.862	p=0.897
15°	**0**	**0**	**0**
	p=1.000	p=1.000	p=1.000
12°	**0,19**	**0,984**	**0,99**
	p=0.880	p=0.115	p=0.120
11°	**0,336**	**0,114**	**0,33**
	p=0.220	p=0.685	p=0.229

diversity (r=0.7582), followed by latitude 15° (Table 5). However, the highest correlation between soft coral and species richness was (r=0.3420) at latitude 21°, followed by latitude 22° (Table 6). Whereas, the maximum regression correlation with average fish abundance was found (r=0.9838) at latitude 12°, followed by latitude 21°. Reefs at Latitude 12° exhibited the highest regression correlation with Shannon-Wiener diversity (r=0.9869), followed by latitude 20°.

Biogeography

Cluster analysis revealed that two primary groups of sites can be distinguished from the data (Fig. 7): Group A is divided into two sub-groups gathering the sites from Djibouti and Yemen with about 58% similarity: sub-group (A1) incorporates sites in Djibouti latitudes 12 and 11° with about 70% similarity (A2) incorporates sites in the country of Yemen (latitude 15°) with about 63% similarity, and sub-group. Group (B) is divided into 3 sub-groups gathering the sites in Jordan, Egypt and Saudi Arabiawith 71% similarity: subgroup (B1) incorporates the sites in Jordan latitude (29°) with about 82% similarity, subgroup (B2) incorporates most of the sites in Egypt at latitudes 27 and some sites in Saudi Arabia at latitudes (20, and 21°) with about 82% similarity.,and subgroup (B3) incorporates the sites is Saudi Arabia at latitudes (21 and 22°) with about 75% similarity. These two main groups (A and B) are connected together with about 52% similarity. The data clearly show that ornamental fish communities in the Red Sea and Gulf of Aden fall into two distinct biogeographical groups.

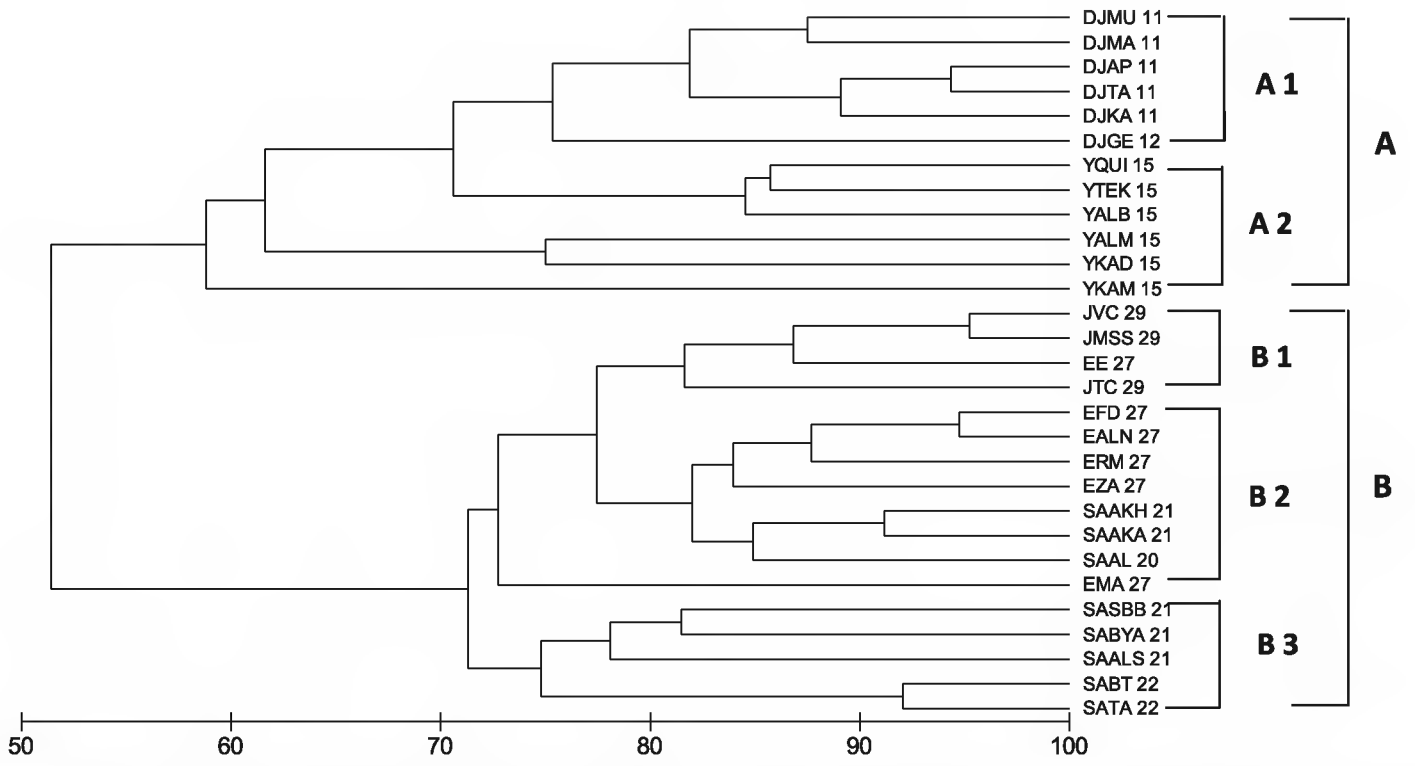

Figure 7. Cluster analysis of relationships between ornamental fish assemblages (Bray-Curtis similarity) from different countries in the Red Sea and Gulf of Aden region. Country Key: J29°= sites at latitude at 29° on the Jordanian coast, JMSS 29= Marine Science Station, JTC 29= Tourist Camp, JVC= Visitor Center; E27°= sites at latitude 27° in Egypt, EALN 27= AL-Noksh, EMA 27= Mahmoudat, EFD 27= Fanar Dolphin, EE 27= Elli, ERM 27= Ras Mohamad, EZA 27= Zorab; SA22, SA21 and SA20° = sites at latitudes on the Saudi Arabia coast, SATA 22= Thoal- Awjam, SABT 22= Bostek/Thoal, SAAKA 21= Alkabeera, SABYA 21= Bayada, SASBB 21= South Batch Bayada, SAALS 21= Al-Sagheera, SAAKH 21= Al-Kherq, SAAL 20= Alleeth; Y15°= sites at latitude along the Yemeni coast, YKAD 15= Kadaman, YKAM 15= Kamaran, YTEK 15= Tekfash, YQUI 15= Quish, YALM 15= Al-murk, YALB 15= Al-Badi; Dj11 and Dj12° =sites at latitudes 11 and 12° along the Djiboutian coast, DJGE 12= Gehere, DJKA 11= Khor Ambado, DJMA 11= Maskali, DJMU 11= Musha, DJTA 11= Tajoura, DJAP 11= ArtaPlaga.

One of the groups characterizes the northern and central Red Sea, whilst the other is in the southern Red Sea and Gulf of Aden.

Discussion

A new and updated checklist of fishes of the Red Sea has recorded a total of 1078 species belonging to 154 families (Golani and Bogorodsky 2010). From this list, a total of 50 fish species used for aquarium trade were investigated during the present study. A database for aquarium fish stocks was established during this intensive survey, and is housed at PERSGA office Jeddah, Saudi Arabia.

This study revealed marked differences in the structure of ornamental fish assemblages with latitude. The presence-absence data for the fifty ornamental fish species used in the aquarium trade in the region support the presence of two main biogeographic gradients in the Red Sea and Gulf of Aden: a south Red Sea and Gulf of Aden latitudinal gradient, and a gradient along the north and central Red Sea. Latitudinal gradients in water quality (temperature, salinity, plankton production) may cause in part this

north-south variation in fish community structure. There are marked changes in the structure of coral reef fish communities moving from north to the south within the Red Sea. Carter and Prince (1981) concluded that gradual changes in salinity and temperature could generate abrupt boundaries for species distributions. Differences in environmental tolerance among species could mean that some are better adapted to conditions prevailing in the south than those further north or vice-versa. Factors in the physical environment including irradiance, salinity, temperature, pressure, nutrients and wastes all influence the distribution of organisms in the sea. The ability of an organism to tolerate changes in these physical environmental factors plays a major role in determining the organism's distribution in the marine environment (Karlenskint et al. 2008). There are strong gradients from north to south in surface water temperature (approx. 6-8 °C), salinity (5–7 ppt), nutrient concentration and turbidity in the Red Sea (Gordeyeva 1970, Morcos 1970, Morley 1975, Edwards and Head 1987, Weikert 1987).

The gradient observed during this study could also be due to different types of habitat available in the different sites, as well as their different amounts of coral cover, which could produce more or less favorable conditions for the development of juvenile fishes (availability of food, food supply, substrate complexity with different coral cover, etc.). This study identified major differences in the faunal composition and relative abundance in almost all of the fish families investigated. They included the studied species of triggerfishes (Balistidae), surgeonfishes (Acanthuridae), butterflyfishes (Chaetodontidae), angelfishes (Pomacanthidae), damselfishes (Pomacentridae), Wrasses (Labridae), dottybacks (Pseudochromidae) and *P. squamipinnis* in the family grouperfishes (Serranidae). Similar results were obtained by (Ormond and Edwards 1987; Roberts and Ormond 1987; Roberts et al. 1992). Sheppard et al. (1992) indicated that there are marked differences among the different regions of the Red Sea in fish species richness, assemblage composition and species abundances. Brokovich et al. (2006) reported a strong correlation between fish assemblages and the different types of habitats at the northern tip of the Gulf of Aqaba. Similar results were also reported by Khalaf and Kochzius (2002).

The fish fauna of the Djiboutian coast is shared with the Indian Ocean and the Red Sea. However, in terms of species composition, the Red Sea influence dominates, especially in areas near to Bab el Mandeb (Barrat and Medeley, 1990). A biogeographic analysis of the Indian Ocean coral fauna based on presence/absence of species revealed a clear pattern of faunal relationships between the Red Sea, Southern Arabia and the Indian Ocean (Khalaf and Kochzius 2002). Habitat strongly influences which species are able to live in a particular place. There are considerable differences in reef structure and coral assemblages from north to south within the Red Sea. In the south, reef structures becomes shallow with macroalgal dominated frameworks (Yemen and Djibouti). In the far south there are few areas of hard substrata, and these are mainly coralline-algal reefs covered with dense growth of the brown algae Sargassum and Turbinaria (Khalaf, personal observation).

A review of the literature describing fish habitat correlations from various regions presents a convincing positive relationship between habitat structural complexity and

reef fish diversity in the Caribbean (Risk 1972, Luckhurst and Luckhurst 1978) and in the Great Barrier Reef (McCormick 1994). The strength of this correlation however, may vary among reef types. Percent of live branching or massive coral, substratum diversity and complexity have several times been identified as important predictors of the diversity of reef fish assemblages (Talbot 1965, Talbot and Goldman 1972, Luckhurst and Luckhurst 1978, Bouchon-Navaro and Bouchon 1989). This study supports the above mentioned studies, and shows that a number of fish species occupy different latitudes. Species varied in their abundances from reef to reef, and adjacent reefs supported different groups of species. As a general conclusion, we suggest that differences among reefs and habitats were among important components of variability in the number of fishes and species of ornamental fishes along the Red Sea and Gulf of Aden.

The high numbers of the clownfish *A. bicinctus* along the Jordanian reefs at latitude 29° compared to other reefs in other latitudes is perhaps due the availability of the sea anemone hosts *Entacmaea quadricolor* and *Heteractis crispa* (Huebner et al. 2012). Chadwick and Arvedlund (2005) proposed that *H. crispa* may serve as nursery habitats for *A. bicinctus* because they host more juvenile fish than does *E. quadricolor*, and Huebner et al. (2012) further documented this relationship using field experiments. The present study revealed that *A. bicinctus,* which is an endemic species to the Red Sea and Gulf of Aden, was a common and abundant species in the northern Red Sea, less common in the central Red Sea and rare or not present in the southern Red Sea and Gulf of Aden. These patterns may be due in part to the distributional and abundance patterns of the above host anemones, but detailed surveys of these anemones need to be conducted throughout the Red Sea to further test these ideas.

Two of the 3 species that belong to the family of dottybacks, Pseudochromidae i.e., *P. springeri* and *P. fridmani* were endemic to the Red Sea (Randall 1992), and both of them were not found along the Yemeni and Djiboutian reefs. The third species *P. flavivertex* which is endemic to the Red Sea and Gulf of Aden (Randall 1992) was recorded in all latitudes except at latitudes 12 and 11° along the Djiboutian reefs during this investigation. A total of 14 butterflyfishes are reported from the Red Sea, of which seven are endemic or range no further than the Gulf of Aden (Randall, 1992). In the present study, 14 species of butterflyfishes have also been reported. Butterflyfish assemblages in the southern Red Sea differ from that in the north (Righton et al. 1996). Other differences occur among butterflyfish. For example, *C. paucifasciatus* is abundant in the Gulf of Aqaba and Gulf of Suez but absent or rare in the southern Red Sea. However, *C. larvatus* is a dominant species in the south but rare in the northern Red Sea and Gulf of Suez and absent entirely from the Gulf of Aqaba. On the other hand, there are some species such as *H. acuminatus*, *C. melapterus* and *C. vagabundus* that are present along the Djiboutian reefs but are not reported in the Red Sea. The results presented in this study demonstrate that there are many differences between the reef fish fauna of the northern and central Red Sea, from that of the southern Red Sea and Gulf of Aden. For example, *P. sqamipinnis* dominated fish assemblages in the northern Red Sea along the Jordanian and Egyptian coasts, whereas *C. viridis* dominated fish assemblages in the central Red Sea, along the Saudi Arabia coast at both latitudes 20 and 21°, and in the Gulf of Aden.

During this survey, *C. viridis* was the most abundant species in the Red Sea and Gulf of Aden. This species dominated the reefs at latitudes 21, 20, 15, 12 and 11°. Similar results were reported at Nuweiba (Ben-Tuvia, 1983), at Djiboutian reefs (Barrat and Medley 1990), at Sanganeb atoll (Krupp et al. 1993), and in Eritrean reefs (Daw et al. 2001). *C. viridis* usually forms large aggregations and is found associated with large heads of *Acropora* corals that provide shelter from predators and a nocturnal retreat. Thus, these distributional patterns for this fish may indicate a higher abundance of large *Acropora* corals on southern than northern reefs in this region. The second most abundant species was *P. squamipinnis*, which dominates the reefs at latitudes 29, 27 and 22°. Similar findings were recorded at the Japanese Garden reef site at Eilat (Rilov and Benayahu 2000), at Nuweiba (Ben-Tuvia et al. 1983), at Sanganeb Atoll (Krupp et al. 1993), and on Jordanian reefs (Khalaf and Kochzius 2002). This species occurs usually in small to very large aggregations around rock or coral heads. These two species feed on plankton above rich beds of live coral (Khalaf and Disi 1997). These patterns indicate the importance of live coral cover, reef rugosity, and availability of plankton in the distribution of these reef fishes.

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